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Summary

The United States' future economic security will remain linked to an efficient transportation system of air, rail, and highway vehicles that depend on a continuous supply of affordable liquid fuels with characteristics enabling vehicle manufacturers to meet increasingly stringent environmental regulations. In the current supply/demand situation, the Nation's transportation fuel requirements are met in part by crude oil and refined products from unstable regions of the world. Crude oil delivery and refining in the Untied States is concentrated in the Gulf Coast region, which presents concerns regarding destructive weather conditions. Additional challenges, including urban and regional air pollution, greenhouse gas emissions, and the availability and cost of transportation fuels, present unique issues that must be addressed to safeguard economic growth, social stability and public health.

Technology is now in hand for producing synthetic oil, and oil products from coal. Liquid fuels from coal are clean, refined products requiring little if any additional refinery processing, are fungible with petroleum products and, therefore, can use the existing fuels distribution and end-use infrastructure. There are preliminary analyses [Mitretek Technical Report 2005-08, "A Technoeconomic Analysis of a Wyoming Located Coal-To-Liquids Plan"] that indicate synthetic oil costs may drop into the $35 per barrel range after several initial higher cost plants are built. This estimate assumes near-zero atmospheric emissions of criteria pollutants, assumes reduced water use through air coolers instead of water cooling, and assumes carbon capture and sequestration. However, no commercial U.S. plants have been built. The primary barrier to commercial introduction of the technology has been the volatility and uncertainty of world oil prices. The private sector financial markets are best positioned to evaluate whether, when, and how to build coal to liquids plants given this market uncertainty.

The Resource

Coal is the most abundant fossil fuel resource in the United States. Recoverable coal reserves are estimated (as of January1, 2005) at 267 billion tons. As coal mining technology improves and additional geological information becomes available, this reserve estimate will grow, since it is based on current mining methods and the measured and indicated reserves within a total U. S.

coal resource base estimated at nearly 4 trillion tons. These coal resources are widely distributed throughout the United States with recoverable reserves located in 33 states.

Based on current annual production of nearly 1.1 billion short tons, the United States has an approximate 250-year supply. However, this estimate needs to be placed within the context of the projected use of domestic coal in the United States and how coal reserves and resources are defined and quantified. To the first point, the Energy Information Administration (EIA) projects a steady rise in coal consumption to 1.78 billion short tons by 2030 in its reference case forecast. The increase is largely due to the projected increase in new coal-fired power generating capacity, projected to increase at 1.7% per year through 2030. To the second point, the EIA estimates the "demonstrated coal reserve base" at 494 billion short tons. With anticipated advances in mining technology, there is the potential to access a significant portion of the reserve base, and support some degree of increased production of coal for a coal-to-liquids industry.

Background: Coal to Liquids Production

Production of liquid fuels from coal has a long history, and the significant advances made in technology over the past two decades make it a potential component of a strategy to increase domestic production of liquid fuels. In the early 1900's coal was first reacted with hydrogen and process solvent at high temperature and pressure, and produced a coal-derived liquid or synthetic crude oil. This direct liquefaction approach was later improved and used by Germany in the second world war to fuel the Luftwaffe with high octane aviation gasoline. In the 1920's two German scientists, Fischer and Tropsch, passed synthesis gas – consisting of carbon monoxide and hydrogen – over metallic catalysts and produced pure hydrocarbons. These hydrocarbons produced by the Fischer-Tropsch (FT) process proved to be excellent transportation fuels. This overall coal-to-liquids process, known as indirect liquefaction because it first involves complete breakdown of the coal to synthesis gas, was used commercially in the 1950's by the South African Synthetic Oil Corporation (SASOL) to produce transportation fuels (gasoline and diesel) using synthesis gas produced by the gasification of coal. Since then, SASOL has built two large facilities that produce over 150,000 barrels per day of transportation fuels. The South African government enabled these plants to be built by providing a price floor safety net for SASOL's coal liquids. In both cases, Nazi Germany and Apartheid South Africa, the primary motivation for government support of coal liquids was that the countries were not able to access world oil markets.

Technology Status

The U.S. Government – directly and through industrial partnerships and international cooperation – has for over 30 years supported R&D on both direct and indirect technology. The Government programs resulted in improved processes, catalysts and reactors. These indirect liquefaction of coal processes produce clean, zero sulfur liquid fuels that are cleaner than

required under the EPA Tier II fuel regulations. These fuels are compatible with petroleum fuels and can utilize the same distribution infrastructure. Because these fuels are essentially refined products, very little if any additional refinery capacity would be needed for their upgrading. Indirect liquefaction technology has a proven track record and is technically viable. Although SASOL has successful commercial plants in operation, the integration of modern entrained-flow coal gasification with advanced slurry-phase FT synthesis has not yet been demonstrated. Preliminary studies [Mitretek Technical Report 2005-08] indicate that first plant costs would have products in the $45 per barrel range, but no commercial U.S. plants have been built, making cost estimates difficult. Still more difficult to estimate is the cost of production for subsequent plants, but these studies indicate that coal liquids might eventually be produced in the $35 per barrel range if domestic construction experience is gained. However the principal market barrier discussed would remain. China, with an increasingly large appetite for liquid fuels, scarce supply of domestic petroleum and large coal resources, is reportedly moving toward commercialization of coal-to-liquids technologies. In the U.S. demonstration plant to produce liquid transportation fuels from anthracite waste was competitively selected in January 2003 under DOE's Clean Coal Power Initiative. However, the project has been unable to obtain financing for the private sector cost share.

Opportunities and Impediments

As noted, the U.S. is endowed with over 267 billion tons of recoverable coal reserves, equivalent to 250 years supply at current usage rates. The opportunity exists to use coal-to-liquids (CTL) technologies to produce clean transportation fuels that could supplement petroleum supply if world petroleum prices remained elevated over the approximately 30-year time horizon required to pay back the significant initial capital investment.

Despite current world oil prices, there are significant existing impediments to deploying CTL technologies: first and foremost, the uncertainty and volatility of the world oil price; high capital investment for the plants; technical and economic risks associated with first-of-a-kind plants; environmental concerns associated with increase coal production and the coal to liquids industrial process; public attitude to increased coal use; siting and "not in my backyard" issues for new plants; and increasing the supply of coal given a supply chain that is already stretched to capacity. Over the long term, the capital cost of the plants could be reduced by the experience gained in the actual construction and operation of commercial facilities. It is well documented that first-of-a-kind plants are always significantly more costly than subsequent or Nth plants. While coal liquids technology is proven, the domestic construction industry has an opportunity to reduce its costs with increased experience. Environmental concerns can be addressed by using clean coal technologies to reduce emissions of criteria pollutants, and in the future to capture and sequester carbon dioxide to limit greenhouse gas emissions. Siting issues can be mitigated by maximizing retrofit opportunities at existing coal-fired power plants.

Environmental Issues

The technology that underlies CTL fuel production offers the potential for low emissions of criteria and toxic air pollutants, water quality, and solid wastes. Nonetheless, this promise of high performance needs to be verified during the design and initial operations of first-of-a-kind CTL plants and costs may be prohibitively expensive. Significant water demand will remain a constraint on CTL fuel production, particularly in regions with limited water resources. Other key environmental issues are the impacts on land, land use and watersheds caused by coal mining and the traffic and local development associated with CTL plant construction and operations. These considerations may prevent the construction of CTL plants in particular areas. However, coal resources suitable for CTL fuel production are widely distributed throughout the United States. The impact of site-specific environmental constraints on the development of a strategically significant CTL industry will depend in part on how environmental regulations are applied on local, regional, and national levels. Permitting delays should be anticipated, especially in view of the large size of and lack of experience in operating CTL plants. Even if the environmental risks are addressed, there is a very good possibility of public reluctance to accept the need for large new industrial facilities, particularly those using coal.

At present, no requirements exist in the United States to manage carbon emissions from fossil fuel sources. However, in full recognition of the importance of carbon management an extensive research and development program is underway to develop technology, processes and systems to capture and store the carbon dioxide produced during the conversion process. The carbon dioxide could be stored in deep saline formations or sold for use in enhanced oil recovery operations. It is possible that CTL plant emissions and the emissions from utilization of CTL products would be comparable to those associated with the production and consumption of petroleum-based fuels.

Next Steps

The greatest market barrier for CTL is the volatility and uncertainty of future world oil prices. The private sector is best positioned to evaluate market or oil price risk and respond accordingly with an appropriate deployment strategy.

Although past department efforts and some Congressionally directed funding has focused on production of liquid fuels from coal, the FY 2007 Budget does not support these activities. Coal to liquids is a mature technology receiving funding from the private sector for evolutionary advances and incremental improvements and therefore not consistent with the Administration's Research and Development Investment Criteria. Although the FY 2007 Budget does not directly support CTL technology, there are some overlapping activities directed at electricity and hydrogen generation that the private sector could apply to reducing production costs and technical risks, and improving environmental performance of coal to liquids plants. The FY

2007 Budget supports production of hydrogen from coal and some funding will be used for development of liquids that while not applicable for conventional internal combustion engines because their hydrogen content is too high, could be an efficient way to move fuel for hydrogen applications through existing infrastructure. The FY 2007 Budget promotes the goal of reducing dependence on foreign sources of oil through development of technologies consistent with the Research and Development Investment Criteria, such as cellulosic ethanol, battery technology, and hydrogen, among others. Over the mid to long term, these technologies could reduce demand for conventional sources of petroleum and ease pressures on world oil prices.

The resource exists, current technology is available and it is possible that continued evolutionary R&D will produce advanced processes that will continue to modify the private sector's analysis of whether the economic and environmental performance of the processes used in the implementation of a coal-to-liquids industry for the production of alternate fuels justify plant construction, in tandem with the primary consideration of petroleum market risk.

If economic, these fuels could contribute to reducing our dependence on oil imports and significantly contribute to the Nation's energy security.

This completes my testimony, and I would be pleased to respond to your questions.